

plurality of permanent magnets located around a central core and secured against centrifugal force by a non-magnetic outer sleeve. Preferably, such magnet assemblies are formed as a unit that can be assembled onto the turbocharger shaft by retaining an annular arrangement of motor magnets in an assembly between central and outer sleeves.

In a preferred embodiment of the invention, the magnets can be secured around the central sleeve and within the retaining sleeve by a high-temperature structural adhesive, and the retaining sleeve can include inwardly projecting portions at its ends for an engagement with the ends of the magnets. Such a magnet assembly can be removably mounted on the turbocharger shaft between the turbocharger bearings and clamped in place by the axial force exerted on its ends by shaft sleeves when a rotor lock nut is tightened. The central core of the magnet assembly may be formed with a plurality of planar magnet-locating surfaces and ends, having a reduced surface area to reduce heat transfer to the magnets. In preferred magnet assemblies the inside surface of the central sleeve may be relieved in its central portion to reduce the area of contact with the turbocharger shaft, and reduce the heat flow from the shaft into the magnet assembly. In addition, in the turbocharger-electric motor assembly, or in the magnet assembly itself, insulating material may be placed between the central sleeve of the magnet assembly and the turbocharger shaft to limit heat

## United States Patent [19]

Woollenweber et al.

US006085527A

[11] Patent Number: 6,085,527

[45] Date of Patent: Jul. 11, 2000

## [34] MAGNET ASSEMBLIES FOR MOTOR-ASSISTED TURBOCHARGERS

[75] Inventors: William E. Woollenweber, Carlsbad; Edward M. Halimi, Montecito, both of Calif.

[73] Assignee: Turbodyne Systems, Inc., Carpinteria, Calif.

[21] Appl. No.: 08/857,031

[22] Filed: May 15, 1997

[51] Int. Cl. 7 F02B 37/14

[52] U.S. Cl. 60/607; 310/156

[56] Field of Search 60/607, 608; 310/61, 310/156, 262, 271; 415/115, 177; 416/95, 244 A, 244 R

## [56] References Cited

## U.S. PATENT DOCUMENTS

2,076,499	4/1957	Ljungstrom	123/170
2,173,480	9/1939	Vugt	308/77
2,578,785	12/1951	Davis	230/209
2,649,048	8/1953	Pazdlo et al.	
2,782,721	2/1957	White	
2,835,286	4/1958	Beitz	310/83
3,163,790	12/1964	White	310/54
3,531,670	9/1970	Leuden	310/156
3,557,540	1/1971	Weiss	
3,572,982	3/1971	Kondos	417/423
3,961,199	6/1976	Bronicki	
4,445,337	5/1984	McCrory	60/608
4,453,381	6/1984	Dinger	60/612
4,565,502	1/1986	Woollenweber	417/407
4,541,777	2/1987	Woollenweber	384/49
4,708,091	11/1987	Lauerk	125/4142
4,708,602	11/1987	McEachern, Jr. et al.	417/407
4,746,827	5/1988	Ochiai et al.	310/156
4,776,168	10/1988	Woollenweber	60/602
4,827,170	5/1989	Kawamura et al.	310/156
4,850,193	7/1989	Kawamura	60/608
4,878,347	11/1989	Kawamura	60/608
4,882,905	11/1989	Kawamura	60/608

(List continued on next page.)

## FOREIGN PATENT DOCUMENTS

295985	12/1988	Europat Pat. Off.
367406	9/1990	European Pat. Off.
2475889	9/1991	France .
57-212331	of 0000	Japan .
58-222201	12/1983	Japan .
59-49223	3/1984	Japan .
3202633	4/1991	Japan .
4-112921	4/1992	Japan .
5-5419	1/1993	Japan .
267149	8/1997	United Kingdom .
3048585	3/1999	United Kingdom .

## OTHER PUBLICATIONS

SAE Technical Paper 940842 "Turbo-Compound Cooling Systems for Heavy-Duty Diesel Engines", 1994, W.E. Woollenweber.

Proc. Instn. Mech. Engrs. vol. 189, 43/75, "Experimental and Theoretical Performance of a Radial Flow Turbocharger Compressor with Inlet Prewhirl", 1975, pp. 177-186, F.J. Wallace.

Primary Examiner—Michael Koczo  
Attorney, Agent, or Firm—Brinks Hofer Gilson & Lione

## [57] ABSTRACT

An integral turbocharger-electric motor assembly permits the elements of an operating electric motor and turbocharger to be easily assembled into a relatively compact and reliable operating unit. To act as an electric motor rotor, the turbocharger shaft carries a magnet assembly in its central portion between the shaft bearings, in such proximity to the stator windings to provide electromagnetic coupling for the effective conversion of electric energy applied to the stator winding into rotational force applied by the magnet assembly to the turbocharger shaft. The magnet assembly includes a plurality of permanent magnets located around a central core and secured against centrifugal force on a non-magnetic outer sleeve. Such magnet assemblies are preferably formed as a unit that can be assembled onto the turbocharger shaft by retaining an annular arrangement of motor magnets in an assembly between central and outer sleeves.

22 Claims, 4 Drawing Sheets

